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LUNDY PACKING COMPANY
CLINTON, NORTH CAROLINA

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SUMMARY

In May and June 1993, investigators from the National Institute for Occupational Safety and Health (NIOSH) conducted a health hazard evaluation (HHE) at the Lundy Packing Company in Clinton, North Carolina. This HHE was in response to requests submitted independently by Lundy employees and the North Carolina Department of Environment, Health, and Natural Resources. The purpose of this evaluation was to investigate the occupational transmission of brucellosis among kill floor employees of this swine abattoir.

The industrial hygiene investigation included observation of general work practices, personal protective equipment use, and a review of the existing and planned ventilation system in the kill floor. The medical evaluation included questionnaire administration and a serologic survey (using the standard tube agglutination [STA] and the 2-mercaptoethanol [2-ME] tests) of 154 (99%) of the 156 kill floor employees. A suspected case of brucellosis was defined by: 1) STA titer $\geq$ 160, and either (a) two or more symptoms consistent with brucellosis or (b) a positive 2-ME test (2-ME titer $\geq$ 20).

The medical evaluation revealed that 30 workers (19%) met the case definition for brucellosis. Sixteen (53%) of the 30 represented newly identified cases. The head (33%) and red offal (25%) departments within the kill division had the highest percentage of workers identified as cases.

A history of being cut or scratched while working appeared to be associated with meeting the case definition (odds ratio [OR]=6.3; 95% confidence interval [CI]=0.9-267), and working in the head department appeared to be associated with a positive 2-ME test (OR=2.7; CI=0.9-7.8).

An evaluation of a brucellosis outbreak among kill floor employees of the Lundy Packing Company in Clinton, North Carolina, revealed that 19% of kill floor workers met our epidemiologic case definition for brucellosis. Potential risk factors identified included experiencing cuts or scratches during work and working in the head department. Recommendations were made to management and employees concerning personal protective equipment, education, and ventilation, although identification and eradication of the disease in swine is considered the primary means of prevention. NIOSH is working with the United States Department of Agriculture (USDA) and the State of North Carolina to determine the source(s) of infection among swine processed at the plant.

KEYWORDS: SIC 2011 (Meat Packing Plants); Brucellosis, Swine Abbatoir, Ventilation, Brucella.

INTRODUCTION

In March 1993, the National Institute for Occupational Safety and Health (NIOSH) received a request from employees at the Lundy Packing Company (LPC) in Clinton, North Carolina, to evaluate the occupational transmission of brucellosis. In April 1993, NIOSH received a request from the North Carolina Department of Environment, Health, and Natural Resources (NC DEHNR) for technical assistance in evaluating the same problem at LPC. On May 5, 1993, investigators from NIOSH conducted an initial site visit, during which plant processes and potential sources of exposure to *Brucella suis* were reviewed. A second site visit was performed during the week of June 21, 1993. During this second site visit, a more extensive industrial hygiene review of the workplace was conducted and a medical survey of kill division employees was performed. Medical survey participants were notified of their initial test results in August 1993, and had an opportunity to discuss their results with the NIOSH medical officer during his visit to Clinton in September 1993. Management officials and employee representatives were notified of preliminary results and recommendations in a letter dated August 24, 1993. Further medical test results were sent to participants in January 1994.

BACKGROUND

Facility/Process Description

LPC is a 900-employee swine abattoir and packaging plant located in Sampson County, North Carolina. The plant was established in 1950 and has subsequently undergone periodic renovations and expansions. Approximately 190 employees work in the kill division, which includes the following departments located on the kill floor: kill, white offal, red offal, head, pancreas, and pet food. Maintenance personnel also work on the kill floor. The wastewater, lard rendering, and inedible rendering departments are in the kill division, but not located on the kill floor. The kill floor is a 20,000 ft^2 (15000 ft^2 1st. floor, 5000 ft^2 mezzanine) area in a larger building, constructed in 1985, that also includes the cut floor (Figure 1). The kill and cut floors are physically isolated by a wall and have separate ventilation systems. They are directly connected only by a large freezer, and, because of cross-contamination concerns, workers are discouraged from traveling between the two areas.

The plant is not unionized, and average employment is 12-13 years for workers who have remained on the job over 4 months (most turn-over occurs in the first 2-3 weeks of employment). The kill division operates only a day shift, and weekend work is unusual. The evening shift consists of a sanitation crew, which performs clean-up and disinfection. Kill division employees have access to a locker room with showers and a break-room. Transfer between divisions, and between departments within the kill division, is unusual.

The plant processes approximately 8000 hogs/day, and is designed to slaughter only "prime" hogs (4-5 months old, 180-280 lbs). Deliveries begin at 12 a.m., when the hogs are delivered to a holding stockade for grading. According to LPC, most livestock comes from within a 50 mile radius of the plant, although hogs purchased from buying stations may include hogs originally raised in another state. Slaughtering begins at 6:30 a.m. and generally follows a standard

process.[1] A summary of process steps on the kill floor is presented in Appendix A and a further description of job tasks is presented in Table 1.

Previous Evaluations

In 1991, five cases of brucellosis in persons working at LPC were reported to NC DEHNR. In August 1991, NC DEHNR issued a letter to LPC in which the following topics were discussed: 1) the importance of buying only hogs from brucellosis-free herds and methods for achieving this goal; and 2) the role of personal protective equipment (PPE) in preventing brucellosis. In 1992, 18 cases of brucellosis in persons working at LPC were reported to NC DEHNR, all of which occurred among kill floor employees. In November 1992, the NC Department of Labor, Division of Occupational Safety and Health, Bureau of Consultative Services, issued a report with the following recommendations: 1) management should provide education and training to employees on the hazards of brucellosis and emphasize the importance of good personal hygiene on the job; and 2) employees should use rubber gloves and eye protection to reduce contact with potentially infectious materials. In addition, the United States Department of Agriculture (USDA) has been working with State and company officials in attempting to trace the source of potentially infected hogs. Nine cases of brucellosis, all in persons working on the kill floor at LPC and all identified independent of the NIOSH HHE, were reported from Sampson County between January 1 and December 1, 1993.

EVALUATION CRITERIA

Medical

Brucellosis is a disease caused by bacteria of the genus *Brucella*. *Brucella* species known to cause human disease and their usual reservoir hosts are *B. abortus* (cattle), *B. melitensis* (goats and sheep), *B. suis* (swine), and *B. canis* (dogs). Brucellosis in pigs is a chronic disease manifested by sterility or abortion in sows, high piglet mortality rates, and orchitis in boars.[2]

Brucellosis is a notifiable disease in all states except Nevada. One-hundred five cases of brucellosis were reported by state health departments to the Centers for Disease Control and Prevention (CDC) in 1992. Table 2 lists the six states with the most reported cases of brucellosis over the two year period of January 1, 1991, to December 31, 1992. Table 3 lists the 5 counties with the most reported cases of brucellosis for the same time period. Final 1993 data were incomplete at the time this HHE report was written.

Population at Risk

A large percentage of reported brucellosis cases in the U.S. are associated with ingestion of unpasteurized dairy products; these are usually *B. melitensis* infections associated with ingestion of products from the Mediterranean countries and Mexico.[3] Occupational transmission of brucellosis occurs primarily among packing plant workers, veterinarians, livestock producers, and laboratory workers.[3-8] Brucellosis peaked in incidence in 1947 at 6,321 cases, dropping to less than
200 cases in the 1970s,[2] although some estimate that only 4-10% of cases are recognized and reported.[7]

Many studies of brucellosis among abattoir (packing plant or slaughterhouse) workers have been done.[1,9-12] Among abattoir workers, transmission of brucellosis occurs primarily by skin and conjuctival contact and by inhalation.[13] Although workers in the kill areas are at greatest risk of acquiring brucellosis,[14] workers in other areas of abattoirs are also at some risk of infection.[2,9] Intact skin is thought to be protective against infection with *Brucella* organisms; however, persons at risk commonly have breaks in their skin as a result of their occupation.[3] Reports of

person-to-person transmission are rare.[15]

Manifestations of Disease

The incubation period for brucellosis varies from 5 days to several months, with more than 30 days being typical. The signs and symptoms of brucellosis are nonspecific and may be present for prolonged periods. Onset may be acute or insidious, and usual symptoms include weakness, fever (constant or intermittent), chills, sweats, headaches, myalgia/arthralgia (muscle/joint pain), anorexia (decreased appetite), and weight loss. Physical findings (other than fever) are not common and are most commonly limited to lymphadenopathy (enlarged lymph glands) and splenomegaly (enlarged spleen).[11]

The course of illness is variable. Symptoms often last months without treatment and may be very debilitating. Even with appropriate treatment, a patient may be ill for a month or longer, with approximately 2-10% having one or more relapses.[4] The relapse rate is higher if the prescribed course of therapy is discontinued before six weeks. Although in the U.S. mortality due to brucellosis is rare, complications do occur and most commonly include osteomyelitis (infection of the bone), splenic abscess, genitourinary tract infection, pulmonary disease, and endocarditis (infection of the heart lining or valves).[11,16] Persons who have recovered from active infection have some resistance to reinfection.[17]

Subclinical (inapparent) *Brucella* infection is known to occur; the ratio of subclinical to clinical (overt) infection has been reported to vary from 1:1 to 12:1.[11] Investigations of brucellosis outbreaks have reported rates of subclinical infection (agglutinin titer of 160 or greater among asymptomatic persons) of 6-9% among abattoir workers.[1,2,11]

Although cell-mediated immunity plays a greater role in resistance to intracellular organisms (such as *Brucella*), circulating antibodies do provide some protection against brucellosis. The humoral immune response in human brucellosis is characterized by an initial rise in immunoglobulin M antibodies (IgM) that is followed within weeks by a rise in immunoglobulin G antibodies (IgG) and a decline of IgM.[4,18,19] After treatment, IgM may persist at low levels for several years, while IgG levels decline over a period of approximately one year.[16] In the absence of treatment, IgG usually persists; IgG is therefore used as a marker for active infection.[8,19]

Diagnosis

A definitive diagnosis of brucellosis is made by isolation of the causative organism from blood or bone marrow, but brucellosis is more commonly diagnosed serologically using the standard tube agglutination test (STA), sometimes combined with the 2-mercaptoethanol (2-ME) test.[18-21] (The STA is also known as the serum agglutination test [SAT]). In a person with a clinical presentation compatible with brucellosis, a serologic diagnosis is made by a fourfold rise in titer (over a several week period), or by the presence of a single serum titer of 160 or greater.

The STA measures antibodies directed primarily at *Brucella* lipopolysaccharide antigens; cross-reactions may occur in the *Brucella* STA with serum from persons infected with or immunized against the organisms of cholera, tularemia, and yersiniosis. Common antigens have also been shown between *Brucella* species and certain species of *Escherichia*, *Salmonella*, and *Pseudomonas*.[18] The use of 2-ME in the STA destroys the agglutinating ability of IgM antibodies and allows measurement of only IgG. IgG as detected by the 2-ME test is used as a marker for active infection.

Enzyme-linked immunosorbent assay (ELISA) tests are available to measure *Brucella* antibodies. The ELISA tests have been used to differentiate active from inactive brucellosis,[18,22] and are more sensitive than the agglutination tests. Lack of standardization for the ELISA tests is the primary reason why the STA and 2-ME tests remain the most widely used tests in the serodiagnosis of brucellosis.[18]

Treatment
Antibiotic treatment should be given to patients with positive cultures or symptomatic patients with a high (particularly IgG) or rising titer. Combination therapy with tetracycline and streptomycin has been considered the classic treatment for brucellosis. A six-week course of doxycycline (100 mg every
12 hours orally) and rifampin (15 mg/kg per day [maximum of 600 mg] in a single morning dose), the current World Health Organization (WHO) recommendation, has been found to be as effective as doxycycline and streptomycin in most patients in a recent study.[23]

Prevention
Eradication of human brucellosis from abattoir workers will require elimination of the disease in hogs.[3,17] Efforts to decrease brucellosis in abattoir workers have been discussed in the literature[2,24,25] and include: 1) identifying infected hogs and prohibiting their slaughter; 2) personal protective equipment (PPE) to minimize skin and conjunctival contact; and 3) minimizing exposure to potentially infectious aerosols by controlling aerosols at their source, maintaining the kill areas under negative pressure with respect to other work areas, and limiting access to kill floor areas. The impact of the disease among abattoir workers can be minimized by providing educational programs to employees, management, and other administrative personnel which will aid in the early diagnosis and treatment of the disease. A safe, effective vaccine for humans is not available in the U.S.

In 1961 a unified national program to eradicate brucellosis from the Nation's swine herds was begun. Under a cooperative USDA-State program*, in which all states participate, surveillance and procedures necessary for locating infected herds, controlling infected and exposed swine, and eliminating infected swine, are established.[26] In addition, specific provisions exist to designate entire states or individual swine herds as brucellosis-free. As of December 31, 1993, a total of
34 swine herds nationwide were under quarantine for brucellosis in seven states (Florida, Georgia, Hawaii, Oklahoma, South Carolina, Tennessee, Texas). This means that these animals can only be moved ultimately to slaughter, either intrastate or interstate, under permit issued by USDA. At the processing plants that receive brucellosis-infected herds, no special precautions are generally taken to prevent occupational exposure to brucellosis-infected swine.

Environmental

Environmental evaluation criteria have not been established for brucellosis. Detection of the *Brucella* organism, or the presence of disease among workers is sufficient to justify initiating control efforts mentioned above. *Brucella* may be long-lived (many days) in damp, dark environments. Sampling for the presence of *Brucella* organisms in the air may not be effective, as the organism is difficult to culture in the laboratory.

EVALUATION PROCEDURES

Medical

The medical evaluation performed during the week of June 21, 1993, consisted of a questionnaire and a serologic survey. Because all reported cases of brucellosis at LPC had occurred among kill division employees working on the kill floor, and because of the separation (both physical and ventilation) of the kill floor from other areas of the plant, the medical evaluation was limited to workers on the kill floor. All kill division employees working on the

* Cooperative USDA Animal and Plant Health Inspection Service-State Animal Health Swine Brucellosis Eradication Program.

kill floor (156 employees) were asked to participate in the study (employees in the lard rendering, inedible processing, and wastewater departments work in locations other than the kill floor and were not included in this evaluation). Employees were informed of the study by both management and NIOSH personnel. After obtaining informed consent, NIOSH personnel administered the questionnaire, which included questions on medical and occupational history, including current work practices.

All serum samples were sent to a NIOSH contract laboratory (Lab A) where the STA was performed using standard *B. abortus* antigen 119-3, supplied by Difco Laboratory. Each sample was serially diluted to a dilution of 1:640 using standard methodology; the titer reported is the dilution of serum in the last tube showing agglutination. Subsequently, all samples with a titer of 40 or greater on the first STA were sent to a different NIOSH contract laboratory (Lab B) to have the 2-ME test performed. At Lab B, all samples had the STA repeated in addition to the 2-ME test,[27] and all samples were diluted to at least 1:640. In order to monitor the precision of the analysis both laboratories received triplicates of seven samples. The samples which were submitted in triplicate were chosen randomly from among the 154 study participants.

A suspected case of brucellosis was defined by an STA titer $\geq$ 160, and either (1) two or more symptoms consistent with brucellosis (fever, chills, sweats, headache, weakness, tiredness, loss of appetite, weight loss, or muscle or joint aches) in the year prior to the evaluation or (2) a positive 2-ME test (2-ME titer $\geq$ 20). Evaluation of potential risk factors using univariate analysis was done with respect to two outcome measures: having a positive 2-ME test (presence of IgG) and meeting the case definition. Statistical analyses were performed using Epi Info, Version 5.01.[28]

In August 1993, study participants were notified in writing of the results of their STA performed by Lab A and were advised, based on the STA and symptoms they reported on the questionnaire, whether they had evidence of active brucellosis. For the purpose of individual medical follow-up, study participants were advised to see their local physician for evaluation of potentially active brucellosis if they had:
1) STA titer $\geq$ 80, and 2) two or more of the above-mentioned symptoms in the previous year. Several weeks after employees received these results by mail, a NIOSH investigator held one-on-one meetings at the Sampson County Health Department with all participants who wished to discuss their results or ask questions about the NIOSH evaluation. In addition, information about brucellosis was also sent to local physicians.

In January 1994, study participants who had samples analyzed at Lab B were notified in writing of the results of the 2-ME and the repeat STA tests.

Environmental

During the first site visit (May 1993) industrial hygiene activities primarily consisted of reviewing processes in the kill division. Work practices were observed and historical information regarding the packing plant was obtained. Plans for upgrading the facility's ventilation system were discussed with the Chief Engineer. The plant Quality Assurance representative discussed audit procedures for ensuring the effectiveness of sanitation activities.

Industrial hygiene activities during the second site visit (June 1993) consisted of the following:

1. A review of safety procedures and policies with the plant Personnel/Safety Director. This included reviewing safety and health training efforts, as well as PPE policies.

2. A thorough evaluation of work practices on the kill floor. This included observing employee use of PPE, as well as categorizing processing activities based on the potential

for aerosol generation and direct contact with swine tissue and body fluids.

3. Additional information was obtained regarding the existing ventilation system and the planned ventilation upgrade. Pressure checks of various kill division rooms were made to evaluate air flow direction. The relative room pressures were determined with an Alnor Jr. Velometer. The room door was opened about 1 inch and the velometer placed between the door and the door frame. Needle deflection on the analog meter was used to determine air flow direction, an indicator of relative pressure. The Alnor Jr. Velometer is a mechanical, swinging vane air velocity meter with two range settings (0-200 fpm, 0-800 fpm).

RESULTS AND DISCUSSION

Medical

One hundred fifty-four (99%) of 156 kill floor employees participated in the survey. Of the 154 participants, 95 had STA titers of ≥40 from Lab A; these 95 samples were sent to Lab B for 2-ME (and repeat STA) testing.

The STA results for the triplicate samples which were submitted to each of the NIOSH contract laboratories (to monitor the precision of the analyses) are presented in Table 4. Due to the considerable variability present in the results from Lab A, the results from Lab B were used in performing the final data analysis. All 59 samples which were not analyzed at Lab B (samples with a titer from Lab A of ≤ 20) were assigned STA and 2-ME results of <20 (negative) for all data analyses. It is considered unlikely that these 59 serum samples (with STA titers of ≤20 from Lab A) would have had elevated STA titers when tested at Lab B (of 34 serum samples with a titer of 40 from Lab A, subsequent testing at Lab B revealed 32 with titers of <20, one with a titer of 20, and one with a titer of 40).

One hundred five employees (68%) reported experiencing two or more symptoms consistent with brucellosis during the previous year. Thirty-three (21%) persons had positive (≥ 20) 2-ME titers. Thirty workers (19%) met our case definition for brucellosis, with 16 (53%) of the 30 representing newly identified cases (a newly identified case was determined by the employee reporting no previous diagnosis of brucellosis). Tables 5 and 6 present STA and 2-ME titer results for all employees. The head (33%) and red offal (25%) departments had the highest percentage of employees identified as cases (Table 7). Symptom rates among the 30 employees who met our case definition are reported in Table 8; the most common symptoms among cases were chills, fever, headache, and muscle/joint aches. Twenty-six of the 30 cases reported two or more symptoms.

A history of being cut or scratched while working appeared to be associated with meeting the case definition (odds ratio [OR]=6.3; 95% confidence interval [CI]=0.9-267); working in the head department appeared to be associated with a positive 2-ME test (OR=2.7; CI=0.9-7.8) and meeting the case definition (OR=2.4; CI=0.8-7.4) (Tables 7 and 9). Other potential risk factors evaluated by univariate analysis, including factors related to work practices, use of personal protective equipment (PPE), and non-occupational factors, were not as clearly associated to the outcome measures (Table 9). Factors possibly relating to a false positive STA, such as immunization or exposure to the organisms of cholera and tularemia, were uncommon and not related to outcome measures.

Environmental

Safety/Health Programs

The plant has a Safety/Personnel Director and a first-aid station. Management reported

conducting seminars on brucellosis which emphasized the importance of regular hand washing. A plant safety committee, including representatives from each area of the plant, meets on a monthly basis to review safety issues and conduct audits. Management indicated that there are plans to meet with employees on an annual basis and review the potential for infection with *Brucella*. Information sheets regarding the symptoms of brucellosis were posted in the kill division during the summer of 1992.

There are no written PPE policies for the kill division, although the company does require certain protective gear. Mandatory PPE consists of hard-hats, metal mesh gloves (for workers using knives), hearing protection, arm-guards, and safety shoes. Face shields are required at the splitter station on the mezzanine. Rubber gloves and faceshields are available in the nurse's office and supply room for use in the kill department; their use is not mandatory. PPE is not shared. Employees are required to seek assistance immediately if there is any break in the skin. Gloves and finger cots are mandatory if a worker has a cut. There is no medical surveillance program other than audiometric testing. There is worker rotation at some stations due to musculoskeletal conditions from ergonomic hazards.

Workplace Observations

A detailed description of the various tasks/areas in the kill division is presented in Table 1. This table also includes a qualitative evaluation of the potential for employees' unprotected skin to contact internal organs, blood, meat, etc., as well as the potential for the task to generate aerosols. Each task/area was ranked as either low, medium, or high regarding these two categories. Concerning the potential for aerosol generation, there are only a few stations where powered cutting utensils are used (head-drop, splitter). Two powered saws are used at the splitting station. Work involving these power saws is most likely to create aerosols of hog tissue and/or body fluids. Most other work is done with fleshing knives. At the kill station directly after the stunner, there is a high potential for splattering with blood. The employee at this station ("sticker"), manually lances the carotid artery and must rapidly back away to avoid the ensuing spurt of blood.

Due to the assembly line nature of the work (hogs are hung from shackles on a continuous chain conveyor for processing), and the need to separate various organs and body parts at each stage, workers are in very close contact with each other throughout the kill floor. In the white and red offal departments there is considerable direct contact with animal viscera. Many of the employees in these departments were not wearing gloves. Only a few workers were observed wearing face-shields. Adherance to the use of the mandatory PPE appeared to be good at the time of the NIOSH site visits.

The QA department samples surface areas 4 days a week in 27 contact areas throughout the kill division to assess total plate counts/colony forming units. No speciation is conducted. If "high" counts are observed, additional cleaning is conducted and procedures reviewed. Disinfection procedures are established by the company providing the sanitizing chemicals (chlorine based liquids, quaternary ammonium compounds). Chemicals are all pre-weighed to ensure the proper strengths are consistently used. The QA department also conducts periodic housekeeping audits.

Ventilation

The kill floor is equipped with powered roof ventilators that can be used to increase circulation. Except for the scale room, the entire kill floor is on a common ventilation system. Outside air is obtained from a large screened opening on the north end of the mezzanine. The mezzanine is isolated from the first floor except for the stairwell and conveyor pass through. The bleed line is somewhat isolated from the machine line by a floor to ceiling wall for most of the length of the building. Currently, the roof ventilation at the mezzanine provides 8600 cubic feet per minute (cfm) exhaust, 5578 cfm total exhaust is provided for the machine line, and 9800 cfm exhaust is provided on the bleed line. Supply air for the machine and bleed line is through open doors. In

the scale and red offal rooms, air is recirculated through refrigeration units to provide cool air. There is no local exhaust provided. The most likely pathway for air to be exhausted from these rooms is via pass-throughs into the mezzanine roof ventilators. The kill division operates under negative pressure with respect to outside and the cut division.

According to the Chief Engineer, there are plans to install two heating, ventilating, and air-conditioning (HVAC) systems to provide approximately 120,000 CFM of supply air to the kill division. This system will discharge filtered, conditioned air at the ceiling level. Some roof ventilators will still be needed, and there are plans to close the large outside doors. Additional exhaust will also be provided. The goal is to ensure one complete air change every 1.5 minutes. This installation is designed to make the relative pressure in the mezzanine area positive with respect to the mechanical and bleed line.

CONCLUSIONS

The results of our evaluation suggest that brucellosis remains an under-diagnosed disease, even in a situation in which the index of suspicion should be high. Of the 30 employees who met our case definition for brucellosis, 16 (53%) represented newly identified cases. Although inhalation is a potential route of exposure, based on our evaluation of work practices, the ventilation system, and the distribution of the work location of seropositive workers, it appears that skin or conjunctival contact with infectious tissue or fluids is the primary route of exposure in this plant. Our finding that a history of being cut or scratched while working was associated with meeting the case definition also supports this conclusion.

Based on the results of this evaluation we are unable at this time to determine the specific swine or swine herd(s) which were the source of this outbreak. Although the incubation period of brucellosis is variable, the occurrence of multiple cases over a several-year time period suggests multiple sources of infection rather than a single source.

To prevent brucellosis among LPC employees, hogs which are processed at the plant must be free of *Brucella* infection. LPC should continue to work with the USDA, State officials, and swine suppliers to identify means of purchasing only brucellosis-free hogs for processing. Until the time when brucellosis is eradicated from swine sent for processing, use of appropriate PPE to reduce skin and conjunctival contact with potentially infectious tissue, increased education among employees, supervisors, and health care providers, and prompt medical evaluations for symptomatic employees can lessen the risk of infection and enhance the recognition of disease when infection does occur. While the use of more effective PPE should reduce the risk of infection, PPE is unlikely to be totally effective if infected hogs continue to be slaughtered. LPC should continue their policy of limited access to the kill floor for non-essential personnel.

Current USDA policy regarding swine brucellosis calls for the slaughter of infected animals as the primary means of elimination of brucellosis-infected or brucellosis-exposed herds. Although these herds are identified as brucellosis-positive herds when sent to slaughter, slaughterhouses generally take no special precautions when the swine are processed. Alternatives to sending hogs from brucellosis-positive herds to slaughter should be evaluated by USDA. An important consideration should be minimizing worker contact with infected animals.

Specific risk factors (experiencing cuts or scratches while working on the kill floor, working in the head department) were identified as being associated with higher rates of infection with *Brucella*. However, because the rates of seropositivity were high among employees of all kill floor departments, preventive measures should be instituted for all employees who have potential for exposure to *Brucella*. This may include employees in other divisions at LPC, such as the cut division, who were not included in our evaluation but who may have potential exposure to *Brucella* via fresh hog tissue or body fluids.

RECOMMENDATIONS

1. Process only brucellosis-free hogs. While we recognize that the current state of the hog market in the United States may make this difficult, this is the only way to insure prevention of brucellosis among all employees. This could be a cooperative effort among LPC, the State of North Carolina, the USDA, and swine suppliers.

2. Expand the training programs for employees and supervisors to increase understanding concerning prevention and early recognition of brucellosis.

3. Personal protective equipment, such as rubber gloves and face shields, should be used by employees whose work tasks involve contact with tissues and fluids.

4. Continue with plans to upgrade the ventilation system in the kill floor area. However, the system should be designed to maintain the kill departments under negative pressure with respect to the rest of the building (cut division), helping to prevent potential *Brucella*-containing aerosols from spreading to other areas.

5. Medical surveillance of employees at risk of exposure to *Brucella* should be instituted. This should include periodic evaluation of these employees by medical personnel and appropriate laboratory testing. Employees in all parts of the plant who are at risk of exposure to *Brucella* should have ready access to appropriate medical evaluation for symptoms which may be consistent with brucellosis.

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1. Chief Executive Officer, Lundy Packing Co.
2. Lundy Packing Co. employee representative
3. OSHA Region IV
4. North Carolina Department of Environment, Health, and Natural Resources
5. North Carolina Department of Labor

For the purpose of informing affected employees, copies of this report shall be posted by the employer in a prominent place accessible to the employees for a period of 30 calendar days.

APPENDIX A - Summary of Kill Floor Process Steps

Bleed Line

1. Kill Prep area: Hogs are driven into the electric stunner.
2. Stunning and bleeding
3. Shackling

Machine Line

4. Scald-tank: 138° Fahrenheit water for six minutes
5. De-hair: Rotating rubber paddles in a cylindrical chamber
6. Gamblers: Hogs are hung from gambles
7. Washing/singing: Hogs pass through a series of flame singers and washers
8. De-burring/eyelid removing

Mezzanine

9. Evisceration
10. Head dropping: automatic shears to open head
11. "Snatching": white-offal (small/large intestine) and red-offal (heart, liver, lungs) are removed and separated.
12. Splitter - automatic saw splits carcasses lengthwise
13. USDA head and viscera inspection
14. Final trim
15. Gland/Kidney separation and removal
16. Ham Facers - remove fat from sides of carcass
17. Separate white/red offal

Scale Room

18. Finish removing head - carcass inspected, enters chill tunnels into the Cut Division.

Red Offal Room/Head Table/Hogger

19. Heart, liver, lungs separated.
20. Tongues removed
21. Inedibles placed in hogger for grinding/rendering

White Offal Room

22. Chit Stripper line
23. Separate, clean intestines

Pet Food Line

24. Process scraps for pet food.

Table 1
Qualitative Assessement of Contact and Aerosol Generation Potential
By Area/Task Description
Lundy Packing Co., Clinton, NC HETA 93-0775

AREA/TASK DESCRIPTION	Contact Potential[1]	Aerosol Generation[2]
KILL BLEED LINE		
Sticker: 3 Employees (Sticker, Helper, Carcass Tattoo). Sticker wears glove on one hand, no eye protection. Manually lances carotid, dips lance in 180° F water between hogs. Processes up to 900 hogs per hour. Helper assists to properly position carcass. Aprons are worn.	High (blood)	High (blood)
Shacklers: 2-3 Employees. Hang slaughtered hogs on shackles connected to overhead conveyor prior to scald tank.- Workers wearing protective gloves on both hands, aprons, and arm sleeves. Large wall separates Kill Bleed from Kill Machine line.	High (blood)	Low
KILL MACHINE LINE		
Scald Tank/De-hair: Very little employee assistance needed, primarily a mechanical operation.	Low	Low
Gamble: 3-4 Employees. After de-hair, an incision is made in hind-foot tendon, gamble inserted and hog is hung on overhead conveyor where the carcass passes through flame singing and washing.	Low	Low
De-burr/Eyelid Removal: 5-6 employees use fleshing knives to remove portions of the hog ear and eyelid. Employees wear aprons and mesh gloves/armguards.	Medium	Low
MEZZANINE		
35-40 employees and USDA inspectors work in close proximity to each other to conduct numerous processing tasks. The mezzanine is isolated from other areas with the exception of a stairwell and conveyor pass-through. Large screened opening on North side allows outside air into the mezzanine, aided by a large axial fan. Air flow direction is from the front of the mezzanine processing area towards the back (south). Numerous comfort fans are used. Employees wear aprons and mesh gloves if knives are used.		
Head Dropper: 1 employee. Automatic shears are used to cut the neck to allow USDA inspection of the head.	Low	Low
Brisket Cutter: Uses knife to cut the hog brisket	Medium	Medium
Openers: 3 employees use knives to begin evisceration of hogs. gloves worn on one hand, no eye protection.	Medium	Low
Pullers/Snatchers: 4-5 employees, remove red offal (heart/lungs), white offal, hang on conveyor or place on rack. Most wear gloves on one hand, use a knife in the other. Must pull hard and quickly to keep up with conveyor pace.	High	Low
Splitter: 2 employees use powered circular bladed saw to split the carcass in half (sagittal). Workers wear cloth gloves, faceshields or goggles. Saw is dipped in 180°F water between each cut.	Medium	High
Trim/Touchup: 8 employees. Remove stomach, tissue from viscera. Some workers wore rubber gloves in addition to mesh gloves. No eye protection worn.	High	Low
Ham Facer: 3 employees on moving line, use knives to cut and open hams. 1 worker wearing rubber gloves in addition to mesh.	High	Low
Leaf Fat Puller: 7-8 employees on moving line next to Ham Facers. No gloves worn other than metal mesh gloves. No eye protection.	High	Medium

Table 1 (Continued)

AREA/TASK DESCRIPTION	Contact Potential[1]	Aerosol Generation[2]
SCALE ROOM The Scale Room adjoins the Red Offal room and has a separate refrigeration unit to maintain a cooler temperature. There are 7-8 employees who work in this area. There is some worker contact with the removed heads, which pass through on a conveyor to the Red Offal room. Fat content is measured and the hog carcass passes into the chill tunnels prior to entering the Cut Department.	Medium	Low
HEAD AND RED OFFAL ROOM 30-33 employees work in this room in close proximity to each other. Some workers were wearing rubber gloves in addition to the mesh gloves. Heads are placed on a conveyer and trimmer, red offal and livers are packed. Most of these workers wear gloves, armguards and all wear aprons. Considerable hand/arm contact with viscera. Numerous comfort fans in use. Turbulence too great to determine relative room pressure.	High	Medium
WHITE OFFAL ROOM 25 employees work in this room to separate and clean large and small intestines by hand. Some employee were wearing gloves and armguards. 4 of 6 workers on the Chit-Stripper line were wearing face shields. No other employees were wearing eye protection. Very wet and warm in room. Room appears to be under slight negative pressure with respect to the Chitt Packing Room.	High	Medium
CHITT PACKING 2 employees work in this very cool room to pack the cleaned Chitt (intestines) in cases. No gloves are worn.	High	Low
PET FOOD 1-2 employees work intermittently in this room to mix ingredients for pet food preparation.	Low	Low
HOGGER ROOM 1-2 employees work in this room on an intermittent basis to dump "inedibles" into an automated grinder.	Low	Medium

NOTES

1. Contact potential is a subjective (low-medium-high) evaluation of the potential for direct worker skin contact with slaughtered hog internal organs, blood, viscera, meat, etc.

2. Aerosol potential is a subjective (low-medium-high) evaluation of the potential for the described task to generate aerosols during processing.

TABLE 2. Six states with the most reported cases of brucellosis - 1991-1992.

State	1991 cases	1991 incidence*	1992 cases	1992 incidence*	Total cases	2-year incidence*
Texas	36	0.20	27	0.15	63	0.36
California	27	0.09	35	0.12	62	0.20
North Carolina	5	0.07	19	0.27	24	0.35
Illinois	8	0.07	4	0.03	12	0.10
Florida	2	0.01	2	0.01	4	0.03
Washington	3	0.06	1	0.02	4	0.08

* Per 100,000 population

TABLE 3. The five counties in the U.S. with ≥ 10 reported cases of brucellosis - 1991-1992.

County, State	1991 cases	1991 incidence*	1992 cases	1992 incidence*	Total cases	2-year incidence*
Sampson, NC	4	8.5	18	38.1	22	46.5
Los Angeles, CA	9	0.1	9	0.1	18	0.2
Bexar, TX	6	0.5	5	0.4	11	0.9
Hidalgo, TX	8	2.1	2	0.5	10	2.6
Webb, TX	4	3.0	6	4.5	10	7.5

* Per 100,000 population

Table 4
Comparison of the Precision of STA* Titer Results Between Lab A and Lab B
Lundy Packing Co., Clinton, NC HETA 93-0775

Sample No.(submitted in triplicate)†	Lab A	Lab B
1	<20	<20
1	40	<20
1	20	<20
2	160	<20
2	80	<20
2	640	<20
3	160	<20
3	40	<20
3	20	<20
4	40	<20
4	80	<20
4	20	<20
5	40	<20
5	20	<20
5	40	<20
6	40	<20
6	40	<20
6	40	<20
7	20	<20
7	20	<20
7	20	<20

* Standard tube agglutination test
† Seven samples chosen to be submitted in triplicate were chosen randomly from among the 154 study participants.

Table 5
Standard Tube Agglutination Titers for Kill Floor Employees
Lundy Packing Co., Clinton, NC HETA 93-0775

STA Titer Result	Number of Employees	Percentage of Total(154)
≥ 640	10	6
320	12	8
160	8	5
80	6	4
40	5	3
20	1	1
< 20	112	73

Table 6
2-Mercaptoethanol Titers for Kill Floor Employees
Lundy Packing Co., Clinton, NC HETA 93-0775

2-ME Titer Result	Number of Employees	Percentage of Total(154)*
≥ 640	8	5
320	5	3
160	7	5
80	7	5
40	5	3
20	1	1
< 20	121	79

* Rounded to nearest whole number

Table 7
Serologic and Questionnaire Data by Work Area
Lundy Packing Co., Clinton, NC HETA 93-0775

Department	Total No. Employees	No. Cases[*] (%[†])	No. Pos. 2-ME[§] (%[†])	Total No. Reporting Cuts	No. Cases Reporting Cuts
Kill-Mezzanine	37	7 (19)	5 (14)	33	7
White Offal	32	6 (19)	6 (19)	29	6
Red Offal	16	4 (25)	4 (25)	14	4
Head	21	7 (33)	8 (38)	17	6
Petfood	3	1 (33)	1 (33)	3	1
Maintenance	8	1 (13)	3 (38)	7	1
Kill-Bleed	4	0 (0)	0 (0)	2	0
Kill-Machine	12	1 (8)	2 (17)	11	1
Kill-Scale	7	1 (14)	1 (14)	4	1
Supervisors	3	0 (0)	0 (0)	3	0
Kill-Other	11	2 (18)	3 (27)	8	2

[*] Case is defined by STA ≥ 160 and either (1) two or more symptoms consistent with brucellosis or (2) a positive 2-ME test.
[†] Number/number of employees x 100%.
[§] Number of employees with a 2-ME titer of ≥ 20. This number may be greater than the number of cases in instances where the employee had an STA titer of < 160.

Table 8
Symptom Rates Among the 30 Employees Meeting Brucellosis Case Definition
Lundy Packing Co., Clinton, NC HETA 93-0775

Symptom	Number of Employees	Percentage of Total(30)
Chills	21	70
Fever	21	70
Headache	20	67
Muscle/Joint Aches	20	67
Weakness	18	60
Sweats	18	60
Malaise	18	60
Loss of Appetite	16	53
Weight Loss	15	50

Table 9
Odds Ratios of Potential Risk Factors for Two Outcome Measures: Meeting Case Definition for Brucellosis and Positive 2-ME Test
Lundy Packing Co., Clinton, NC HETA 93-0775

Potential Risk Factors	OR* for Case Definition	OR* for Positive 2-ME Test
Experiencing cuts/scratches	6.3; 0.9-267	3.3; 0.7-22
Not washing hands with soap prior to breaks	4.4; 0.4-47	3.8; 0.4-41
Not wearing any type of gloves	0.9; 0.3-2.3	1.3; 0.5-3.2
Having fluid splashed in face	3.7; 0.5-80	1.1; 0.3-5.4
Not wearing glasses or face cover	1.5; 0.5-4.4	1.1; 0.3-5.4
Working in head department	2.4; 0.8-7.4	2.7; 0.9-7.8
Working in kill-mezzanine department	1.1; 0.4-3.0	2.0; 0.7-6.6
Working in red offal department	1.4; 0.4-5.4	1.3; 0.3-4.7
Working with pigs outside work at Lundy	0.6; 0.03-5.08	0.5; 0.02-4.5
Race(Black/Hispanic)†	2.4; 0.8-7.8	1.4; 0.5-3.7

* Odds ratio and 95% confidence interval.
† Non-whites have been identified in a previous study[10] as having higher rates of infection compared to whites.

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